A HIGH PRESSURE TWO-STAGE RECIPROCATING POSITIVE DISPLACEMENT COMPRESSOR UNIT

BACKGROUND OF THE INVENTION

The present invention relates to a reciprocating positive displacement air compressor unit.

In particular, the present invention relates to a high pressure compressor unit which can be used to supply air to pneumatic tools.

Pneumatic tools are used in a lot of technical work due to their practicality and strength. For example, such work may include the application of rivets to sheets metal, nails in wood, tightening and unscrewing the screws which secure the wheels on motor vehicles.

Above all in the professional field, increasing levels of performance are required of such types of tools.

Obviously, improved performance normally corresponds to an increase in the overall dimensions of the tools and the compressor units which power them.

In recent years, to avoid such an unwanted increase in tool dimensions, the direct consequence of which is a loss of tool practicality, the production of high pressure compressors began. The forces required to

perform the above-mentioned work being the same, these compressors, developing air pressure values close to 30 bar, allow a considerable reduction in the dimensions and weight of the tools which until now were normally used with air operating pressures varying between 10 and 15 bar.

The use of high pressure compressed air, a term which in the present text refers to the above-mentioned pressure values close to 30 bar, has brought a series of important problems both to the use and construction of the compressor units.

In particular, the high pressure compressors currently made have many disadvantages, most of which are linked to the difficulty of achieving efficient cooling of the various parts of the compressor. Reaching high air pressures for lengthy periods such as those normally required during professional use of the compressor results in considerable heating of the compressor components and of the air itself, with an evident reduction in the device's overall performance.

Another disadvantage of the known high pressure compressors is their complexity and the dimensions and weight of their mechanical components. Such complexity means that production costs are high, constituting another disadvantage of known compressors.

SUMMARY OF THE INVENTION

The aim of the present invention is to overcome the above-mentioned disadvantages by providing a high pressure compressor unit with efficient cooling, which is functional, simple to produce and practical to use.

The technical features of the present invention, in accordance with the above-mentioned aims, are clearly indicated in the claims herein, in particular claim 1 and, preferably, by any of the claims which are directly or indirectly dependent on claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

Moreover, the advantages of the invention are more clearly indicated in the detailed description which follows, with reference to the accompanying drawings which illustrate a preferred non-restricting embodiment of it and in which:

Figure 1 is a perspective top view with some parts cut away for the sake of clarity, of a preferred embodiment of the compressor unit made according to the present invention;

Figure 2 is a schematic plan view with some parts in cross-section, of the compressor unit illustrated in Figure 1;

Figure 3 is a schematic side elevation of a portable compressor fitted with a compressor unit

illustrated in the previous figures;

Figure 4 is a schematic front view of the compressor unit illustrated in Figure 1;

Figure 5 is a schematic perspective top view, of a detail of the compressor unit made according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in Figures 1 and 2, the numeral 1 denotes a positive displacement compressor unit for compressing air at high pressure, designed for integration, for example, in a portable compressor of the type illustrated in Figure 3 and labeled 2.

The compressor unit 1 is of the two-stage reciprocating type.

In this text the term high pressure refers to air pressures between approximately 23 and approximately 30 bar, that it to say, pressures significantly higher than those normally supplied by most compressors available on the market.

As illustrated in Figures 1 and 2, the compressor unit 1 comprises a central body 3 which has a substantially cylindrical shape, from the sides of which there extend a first and a second cylinder, labeled 4 and 5 respectively.

The central body 3 is connected, at its first end

3a to an electric motor 6 which has a shaft 7 rotating about an axis of rotation A. The shaft 7 is supported by two bearings of the known type and, therefore, not described in further detail.

A circular removable lid 8 is fixed to the second end 3b of the central body 3, opposite the first end 3a.

The first and second cylinders 4, 5 are opposite one another and have respective axes B and C which are parallel with one another.

The axes B, C of the cylinders 4, 5 and the axis of rotation A of the shaft 7 substantially lie in the same plane, labeled P in Figure 4.

The first cylinder 4, which is larger than the second cylinder 5 and has a bigger cylinder capacity, provides a first stage of air compression for the unit 1. The second cylinder 5 provides a second stage of air compression.

Inside each cylinder 4, 5 there are, respectively, a first and a second piston 9 and 10 which slide along the axes B, C.

The rotary shaft 7 is connected to the first and the second pistons 9, 10 by a first and a second connecting rod, respectively 11 and 12.

At a respective small end, 11a, 12a, each connecting rod 11, 12, is rotatably connected to the

respective piston 9, 10 by a pin 13. Around each piston 9, 10, in suitable hollows made in its cylindrical side surface, two shoes 14 are keyed, which guide the alternate motion of the piston 9, 10 in the cylinder 4, 5. Therefore, the guide shoes 14 are inserted between the piston 9, 10 and the relative cylinder 4, 5.

The shoes 14 are advantageously made of polytetrafluoroethylene, a material with a low friction coefficient.

As illustrated in Figure 2, on each of the pistons 9, 10, close to the crown, there is at least one compression ring 15, of the known type and therefore, not described in further detail.

At a first end 7a connected to the central body 3, the shaft 7 has a counterweight 16 to balance the rotation.

As illustrated in Figure 2, at the first end 7a, two cylindrical elements 17, 18 are attached to the shaft 7, the elements mounted off-center on the shaft 7 so that, when roller bearings 19 of the known type are inserted between them, they form cranks for the connecting rods 11 and 12.

The cylindrical elements 17, 18 are positioned and attached to one another and on the rotary shaft 7 by two pegs 20 and more fastening parts of the known type and not illustrated.

At a second end 7b of the shaft 7 longitudinally

opposite the first end 7a and outside the motor 6, a first, axial fan 21 is fitted on the shaft 7, this fan forming a first rotary ventilation part 22 for the unit 1.

The first, axial fan 21 has a plurality of blades, of the known type and not illustrated, and an external ring 23 which connects the individual blades, the ring 23 constituting a flywheel mass for the rotary shaft 7 to which the fan 21 is connected.

A second, radial fan 24 which forms a second rotary ventilation part 25 for the unit 1 is attached on the cylindrical element 17 relative to the first connecting rod 11 and not adjacent to the rotary shaft 7, the fan being attached coaxially to the shaft 7.

As illustrated in Figure 1, on a cylindrical side surface 26 of the central body 3, at the second, radial fan 24, there is a plurality of openings 27 for the exchange of air with the outside.

In particular with reference to Figures 1 and 2, the compressor unit 1 comprises a conveyor 28 of a flow 29 of cooling air generated by the first, axial fan 21 which forms the first rotary ventilation part 22.

The conveyor 28 comprises a laminar structure, extends longitudinally along the axis A and has a first air inlet hole 30 and a second outlet hole 31. The first hole 30, is close to the first, axial fan 21 and

the second outlet hole 31 gives onto the cylinders 4, 5.

As it extends, the conveyor 28 surrounds the electric motor 6 and the latter is struck at a tangent by the cooling air flow 29 conveyed by the conveyor 28.

As illustrated in Figures 1 and 4, the conveyor 28 has a substantially octagonal cross-section close to the first, axial fan 21 and, along its longitudinal length, from its two opposite side faces there extend side portions 32, 33, each designed to direct the cooling air flow 29 onto a cylinder 4, 5.

The conveyor 28 is rigidly attached to the motor 6 and to the central body 3 by a plurality of fastening elements 34, of which one is illustrated in Figure 1.

As illustrated in Figure 5, the compressor unit 1 comprises an intermediate cooling part 35 for cooling the compressed air exiting the first cylinder 4, before it enters the second cylinder 5 which forms the second stage.

The intermediate cooling part 35 comprises a tubular 36 pipe for the passage of the compressed air. The pipe extends along a curved trajectory T and close to the central body 3 and the electric motor 6, outside them.

For a stretch of the curved trajectory T, the tubular pipe 36 comprises two tubular portions 37, 38

through which the compressed air exiting the first cylinder 4 runs in parallel.

The two tubular portions 37, 38 into which the pipe 36 is divided advantageously allow an increase in the heat exchange surface area of the pipe 36, improving the cooling of the compressed air.

The intermediate cooling part 35 is at least partially inserted between the motor 6 and the conveyor 28.

The first and second ventilation parts 22, 25, the conveyor 28 and the intermediate cooling part 35 together form cooling means 39 for the compressor unit 1.

In practice, during a normal compressor 2 operating cycle, for example, to supply compressed air to one or more pneumatic tools which are not illustrated, the compressor unit 1 compresses the air in its cylinders 4, 5, driven by the electric motor 6.

By means of its rotary shaft 7, the electric motor 6 not only drives the alternate motion of the pistons 9, 10, but at the same time drives the rotation of the first rotary ventilation part 22 and the second rotary ventilation part 25.

The first rotary part 22, consisting of the first, axial fan 21, generates the above-mentioned cooling air flow 29, the flow 29 being channeled into the conveyor

28, and heading towards the central body 3 of the unit 1. On this path, the air flow 29 strikes the electric motor 6 at a tangent, carrying heat away from it. Moreover, since the electric motor 6 has radial fins, the heat exchange between the motor 6 and the outside is further increased by the speed at which the air flow 29 travels thanks to the first, axial fan 21.

The cooling air flow 29 is also directed, by each of the side portions 32, 33, onto a respective cylinder 4, 5.

As described above with reference to the motor 6, the air flow 29 strikes each of the two cylinders 4, 5 carrying heat away from them.

The cylinders 4, 5 also have cooling fins, of the known type, designed to increase the surface area for heat exchange with the outside and, therefore, the extent and efficiency of the heat exchange.

Advantageously, the cylinders 4, 5, being opposite one another, allow optimization of the cooling action exerted on them by the air flow 29, achieving improved ventilation.

Moreover, the cooling air flow 29 strikes the intermediate cooling part 35, located and extending close to the electric motor 6, inserted between the latter and the air flow 29 conveyor 28.

The air flow 29, striking the tubular pipe 36 of

the intermediate cooling part 35, carries heat away from it and cools the partially compressed air exiting the first cylinder 4 before it enters the second cylinder 5 where the second stage of compression takes place.

This intermediate cooling of the compressed air optimizes the compression cycle and its efficiency is increased by the presence of the two tubular portions 37, 38 into which the pipe 36 is divided, the portions 37, 38 advantageously increasing the pipe 36 heat exchange surface area.

The second rotary ventilation part 25, consisting of the second, radial fan 24, circulates air in the central body 3, with relative exchange with the outside through the openings 27 made in the cylindrical side surface 26 of the central body 3.

Advantageously, to optimize compression unit 1 compression, it has been proved that the optimum ratio between the respective cylinder capacities of the first cylinder 4 and the second cylinder 5, that is to say, the cylinder capacity ratio between the first and the second stage, is between 5.37 and 5.40.

The present invention is suitable for evident industrial applications, it can also be subject to modifications and variations without thereby departing from the scope of the inventive concept. Moreover, all

the details of the invention may be substituted by technically equivalent elements.